

What is claimed is:

1. A TE dual-mode resonator having first and second modes, the resonator comprising:
  - an enclosure having a cavity with an interior surface;
  - a dielectric resonator body, having a central portion with a plurality of members extending outwardly from the central portion; and
  - the dielectric resonator body coupled directly to the interior surface.
2. The TE dual-mode resonator of claim 1, wherein the dielectric resonator comprises a cross shape.
3. The TE dual-mode resonator of claim 1, wherein the dielectric resonator comprises an "X" shape.
4. The TE dual-mode resonator of claim 1, wherein the dielectric resonator includes at least one coupling groove positioned in the dielectric resonator body at an intersection of the central portion and at least two of the members.
5. The TE dual-mode resonator of claim 1, and further including a mode tuning member that is positioned between adjacent two of the plurality of members.
6. The TE dual-mode resonator of claim 4, and further including a mode tuning member that is positioned adjacent to one of the at least one coupling grooves.
7. The TE dual-mode resonator of claim 1, wherein the members of the dielectric resonator body have a top surface with an angled portion.
8. The TE dual-mode resonator of claim 1, wherein only a portion of a bottom surface of the dielectric resonator body contacts the interior surface of the enclosure.

9. The TE dual-mode resonator of claim 1, wherein the dielectric resonator body includes a recess in the central portion that is positioned adjacent to the interior surface of the enclosure.

10. The TE dual-mode resonator of claim 9, wherein the interior surface of the enclosure further includes a recess that is positioned adjacent to a recess in the central portion.

11. A TE dual-mode resonator having first and second modes, the resonator comprising:

- an enclosure having a cavity with an interior surface;

- a dielectric resonator body, having a central portion with a plurality of members extending outwardly from the central portion;

- the dielectric resonator body coupled directly to the interior surface of the enclosure;

- at least one mode tuning member extending from the interior surface of the cavity, the at least one mode tuning member disposed adjacent to the central portion of the dielectric resonator body to provide tuning for coupling between the first and second modes; and

- at least two frequency tuning members extending from the same surface as the at least one mode tuning member, the at least two frequency tuning members positioned adjacent to selected members of the dielectric resonator body to provide frequency tuning.

12. The TE dual-mode resonator of claim 11, wherein the dielectric resonator comprises a cross shape.

13. The TE dual-mode resonator of claim 11, wherein the dielectric resonator comprises an "X" shape.

14. The TE dual-mode resonator of claim 11, wherein the dielectric resonator includes at least one coupling groove positioned in the dielectric resonator body at an intersection of the central portion and at least two of the members.
15. The TE dual-mode resonator of claim 11, wherein the members of the dielectric resonator body have a top surface with an angled portion.
16. The TE dual-mode resonator of claim 11, wherein only a portion of a bottom surface of the dielectric resonator body contacts the interior surface of the enclosure.
17. The TE dual-mode resonator of claim 11, wherein the dielectric resonator body includes a recess in the central portion that is positioned adjacent to the interior surface of the enclosure.
18. The TE dual-mode resonator of claim 17, wherein the interior surface of the enclosure further includes a recess that is positioned adjacent to a recess in the central portion.
19. A TE dual-mode resonator having first and second modes, the resonator comprising:
- an enclosure having a cavity with an interior surface;
  - a recess formed in the interior surface;
  - a dielectric resonator body, having a central portion with a plurality of members extending outwardly from the central portion;
  - the dielectric resonator body further including a recess in one surface of the central portion;
  - the dielectric resonator body disposed such that the recess of the dielectric resonator body is proximate the recess in the interior surface of the cavity;
  - at least one mode tuning member extending from the surface of the cavity, the at least one mode tuning member disposed adjacent to the central portion of the dielectric resonator body to provide tuning for coupling between the first and second modes; and

at least two frequency tuning members extending from the same surface as the at least one mode tuning member, the at least two frequency tuning members positioned adjacent to selected members of the dielectric resonator body to provide frequency tuning.

20. The TE dual-mode resonator of claim 19, wherein the dielectric resonator comprises a cross shape.

21. The TE dual-mode resonator of claim 19, wherein the dielectric resonator comprises an "X" shape.

22. A TE dual-mode resonator having first and second modes, the resonator comprising:

- an enclosure having a cavity with an interior surface;

- a dielectric resonator body, having a central portion with four members extending radially from the central portion;

- the dielectric resonator body coupled directly to the interior surface;

- at least one mode tuning member extending from the interior surface of the cavity, the at least one mode tuning member disposed adjacent to the central portion of the dielectric resonator body to provide tuning for coupling between the first and second modes; and

- at least two frequency tuning members extending from the same surface as the at least one mode tuning member, the at least two frequency tuning members positioned adjacent to selected members of the dielectric resonator body to provide frequency tuning.

23. A TE dual-mode resonator having first and second modes, the resonator comprising:

- an enclosure having a cavity with an interior surface;

- a dielectric resonator body having crossing members;

- the dielectric resonator body coupled directly to the interior surface of the enclosure; and

a plurality of tuning members extending from the interior surface of the cavity, the plurality of tuning members disposed adjacent to the dielectric resonator body to provide tuning for the TE dual-mode resonator.

24. A filter, comprising:
  - a plurality of TE dual-mode resonators that are coupled together;
  - one of the plurality of TE dual-mode resonators including an input coupling;
  - another one of the plurality of TE dual-mode resonators including an output coupling; and
  - wherein each of the TE dual-mode resonators includes:
    - an enclosure having a cavity with an interior surface,
    - a dielectric resonator body, having a central portion with a plurality of members extending outwardly from the central portion, and
    - the dielectric resonator body is coupled directly to the interior surface.
25. The filter of claim 24, wherein the dielectric resonator comprises a cross shape.
26. The filter of claim 24, wherein the dielectric resonator comprises an "X" shape.
27. The filter of claim 24, wherein the dielectric resonator includes at least one coupling groove positioned in the dielectric resonator body at an intersection of the central portion and at least two of the members.
28. The filter of claim 24, and further including a mode tuning member that is positioned between adjacent two of the plurality of members.
29. The filter of claim 27, and further including a mode tuning member that is positioned adjacent to one of the at least one coupling grooves.
30. The filter of claim 24, wherein the members of the dielectric resonator body have a top surface with an angled portion.

31. The filter of claim 24, wherein only a portion of a bottom surface of the dielectric resonator body contacts the interior surface of the enclosure.
32. The filter of claim 24, wherein the dielectric resonator body includes a recess in the central portion that is positioned adjacent to the interior surface of the enclosure.
33. The filter of claim 32, wherein the interior surface of the enclosure further includes a recess that is positioned adjacent to a recess in the central portion.
34. A method for forming a resonator structure, the method comprising:  
forming a dielectric resonator having at least two crossing members;  
forming an enclosure with a cavity;  
attaching the dielectric resonator directly to the cavity; and  
positioning tuning members adjacent to the dielectric resonator through a selected surface of the cavity.
35. The method of claim 34, wherein forming a dielectric resonator comprises pressing the dielectric resonator out of a ceramic material.
36. The method of claim 34, wherein attaching the dielectric resonator comprises sintering the resonator to the enclosure.
37. The method of claim 34, and further comprising:  
forming a recess in a surface of the enclosure;  
forming a recess in a surface of the dielectric resonator; and  
aligning the recesses in the enclosure and the dielectric resonator when attaching the resonator to the surface of the enclosure.
38. The method of claim 34, wherein forming a dielectric resonator includes forming at least one coupling groove at an intersection of the at least two crossing members.

39. The method of claim 34, and further comprising positioning at least one mode coupling adjacent to an intersection of the at least two crossing members.
40. The method of claim 38, and further comprising positioning at least one mode coupling adjacent to an intersection of the at least two crossing members.
41. A TE dual-mode resonator having first and second modes, the resonator comprising:  
an enclosure having a cavity with an interior surface;  
a dielectric resonator body, having a central portion with a plurality of members extending outwardly from the central portion; and  
the dielectric resonator body coupled to the interior surface.
42. The TE dual-mode resonator of claim 41, wherein the dielectric resonator comprises a cross shape.
43. The TE dual-mode resonator of claim 41, wherein the dielectric resonator comprises an "X" shape.
44. The TE dual-mode resonator of claim 41, wherein the dielectric resonator includes at least one coupling groove positioned in the dielectric resonator body at an intersection of the central portion and at least two of the members.
45. The TE dual-mode resonator of claim 41, and further including a mode tuning member that is positioned between adjacent two of the plurality of members.
46. The TE dual-mode resonator of claim 44, and further including a mode tuning member that is positioned adjacent to one of the at least one coupling grooves.
47. The TE dual-mode resonator of claim 41, wherein the members of the dielectric resonator body have a top surface with an angled portion.

48. The TE dual-mode resonator of claim 41, wherein only a portion of a bottom surface of the dielectric resonator body contacts the interior surface of the enclosure.

49. The TE dual-mode resonator of claim 41, wherein the dielectric resonator body includes a recess in the central portion that is positioned adjacent to the interior surface of the enclosure.